ACCURATE WORK IN PSYCHOLOGY.[1]

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There are periods in the life of a science when it becomes necessary to take a decided stand against the tendencies prevailing at the place and time, when the battle of the moment is not against avowed enemies, but against the very ones that apparently support the cause. The danger that threatens us comes directly from the psychological laboratories. We make experiments without an idea of the first laws of experiment; we make measurements regardless of the fact that a science of measurement exists; we use apparatus without knowing the principles of its construction. Instead of keeping all the conditions, except one, in a series of experiments nearly constant, we vary a lot of them at the same time, often not knowing which ones are varied, and we assume to make deductions from the results of such work. Instead of carefully eliminating or evaluating the sources of variation in our measurements, we prefer to manipulate the results as we think best. Instead of studying our apparatus with the utmost care to find the constants of errors, we prefer to consider that our results are only relative anyway and constant errors do not count.

The struggle for ever increasing accuracy is the vital principle of all the sciences. No astronomer, physicist or biologist would for an instant hesitate to declare that his work aims at the employment of ever more careful methods.

How different is the case in psychology! We frequently hear it stated that psychological experiments and measurements can never be exact or trustworthy; at best they can only give an inkling of the facts of the case. The deduction made is that any particular care or apparatus is unnecessary, all the work can be done by any amateur who has fifty cents to spend for some colored paper. The consequence is that, although we have psychological laboratories on every hand, with new ones added every year, almost all the scientific work of any value comes from two or three laboratories alone. The instruction in psychology is about on the level of "easy lessons for beginners in chemistry," or "physics in the parlor." Such instruction has its value in its place, but the really scientific pursuit of physics and psychology is quite a different matter. I will say nothing about the necessity of long training in the laboratory,[2] of the need of proper equipment in the way of rooms, apparatus, etc.; but I wish to call attention to a fundamental misconception by many American psychologists. This I will do by using a single example for illustration; the reader can

[1] Address delivered at the second annual meeting of the American Psychological Association, New York, 1893.

[2] Science, 1892, XIX. 127.

easily extend the application. It is now nearly a century since Maskeleyne discovered that our mental activities required time for their occurrence. Hundreds of investigations have been made on its varieties and complications, and, yet, — with the greatest care that we can exercise to-day, our measurements of the simplest form of reaction-time give a mean variation of 10σ to 12σ. Putting the average of such a reaction-time at 180σ, this means a mean error of, say, 6%,— a degree of inaccuracy that would not be tolerated in physics. Moreover, we know that these variations are due largely to such factors as distraction of attention, fatigue, general conditions of time and place, errors of apparatus, etc., none of which we attempt to evaluate or to more than roughly eliminate. As soon as we leave the simplest forms of reaction-time the mean variation becomes much larger; when we get to the complex forms of reaction, we sometimes do not know what we are measuring.

What would a true scientist do in such a case? In the first place, years of labor would be spent in getting the sources of variation under control. Scientist after scientist would seek means of controlling the amount of distraction to ever greater fineness and of measuring the effects of the various degrees of distraction on the reaction-time. Still others would step by step evaluate or eliminate the effects of different degrees of fatigue; others would manage to make the conditions of time and place practically constant. The story of such a gradual elimination of sources of error in astronomical recording, reaching over 3,000 years, is told by Jevons.[1] The subject of calorimetry will indicate how physicists go to work; the endless investigations on nerve irritability and conduction furnish a parallel case for physiology. Let us turn to psychology. Year after year, measurements on the time relations of mental phenomena go on at Leipzig with ever increasing accuracy and with the continual discovery of unsuspected facts. Investigations on new subjects that can be treated at first only qualitatively, are also taken up; *e. g.*, experimental æsthetics, association of ideas, etc., but the fact is always kept in mind that each subject taken up should be pushed forward from time to time, ever a little further into the domain of accuracy. And in America? — From one of the leading laboratories we have the bold declaration that accurate work is not even desirable. More than once have the results of measurements been published without a statement of mean variations or probable errors, or of any data that would enable the reader to judge whether the methods were accurate enough to justify the conclusions drawn or not. Wundt considers such amateurism and carelessness to be the most dangerous enemies of modern psychology. It is this tendency to superficiality and dabbling, so common among American students, which must be eradicated at the beginning of their laboratory instruction. In the work of the Yale laboratory the attainment of accuracy and trustworthiness is made the indispensable condition in all research-work.

The illustration given above will serve to indicate the methods of search for errors and the labor spent on their elimination, as they are followed at the Yale laboratory:

1. Errors of the apparatus. The Hipp chronoscope, with which these experiments are usually made, has been rejected as not accurate enough. Aside from the errors due to remanent magnetism, springs, etc., the very construction of the catch-pin (*b.* in Wundt's *Physiologische Psychologie*, 4th ed. II. fig. 217) involves a mean

[1] "Principles of Science," p. 271.

variation of 1σ. We have, therefore, rejected all chronoscopes and developed the graphic method to such a degree that we can make and count records of any desired accuracy with less work than with the Hipp chronoscope.[1] All errors from time-markers have been eliminated by using the spark method. In fact, the degree of accuracy attainable is limited only by the accuracy of the tuning-fork. By an alarm-thermostat placed beside the fork, even the error due to changes of temperature is kept below $\frac{1}{10,000}$ of a second. Thus our apparatus is absolutely accurate for all records in thousandths of a second. I hardly need to say that we use only break-circuit keys for stimulating and reacting. To avoid errors due to muscular tension, we use our specially constructed reaction-key, that has no spring and that can be held in any position.[2]

2. Errors of surroundings. Of course, the experimenter, the recording apparatus and the stimulating apparatus are in a part of the building distant from the person experimented upon. He sits in the reacting room perfectly alone, knowing nothing of what is going on. The warning click of a sounder tells him to concentrate his attention; a click occurs in the telephone, or a Geissler tube flashes out, or an electric shock pricks the skin; he reacts in response and all is again quiet. All light and moving objects are, of course, excluded. Dr. Bliss's experiments have shown that a steady light of moderate intensity causes no distraction; we may consequently at the present stage of accuracy have the room lighted up by an incandescent lamp, if the observer is made more comfortable thereby. Disturbing sounds are probably the worst sources of error; their exclusion has been a difficult problem, but we have solved it by our isolated room. The distractions due to insufficient ventilation, changing temperature, changing barometric pressure and changing humidity have not yet been eliminated, but the arrangements thereto have been made and will be completed before long.

3. Errors due to poor powers of introspection. Trustworthy observation on the fundamental laws of mental life can be made only by trained observers. Let me show you a picture for a moment and then remove it. How much of that picture can you remember? If I had shown it to an average individual, the amount remembered would have been very small; yet you all know the story of Robert Houdin and his son, who by painstaking training were finally able to tell every article in a shop-window after casting a momentary glance at it,—the son, indeed, was able to glance for an instant over the shelves of a library and then tell from memory the title, cover and position of each book.

You had the picture before you for a few seconds; how much more difficult must it be to carefully observe and remember the rapidly changing phenomena of consciousness. The conclusion seems self-evident. You would not put a car-driver to seeking double-stars with the Lick telescope, and I think you will agree with Prof. Titchener, who claims that thorough psychological work can be done only by those trained in introspection. Indeed, it would seem unnecessary to mention the matter, if it were not for the wide-spread impression that everybody is just as capable of

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[1] Bliss, "Researches on Reaction-time and Attention." Studies from the Yale Psych. Laboratory, 1893, p. 3.

[2] Scripture and Moore, "A new Reaction-key and the Time of Voluntary Movements." Stud. Yale Laboratory, 1893, p. 88.

conducting a psychological investigation as the most experienced psychologist. Aside from the lack of technical knowledge and the ignorance in methods of research (research being a distinct art that has to be learned), there is the total lack of training as observers.

4. Errors of statement. There is a fourth source of error of which I am almost ashamed to speak publicly. Psychologists are constantly making measurements and giving the results in figures in a way utterly regardless of the existence of a science of measurement with definite rules. I will not detain you with any remarks on the subject. To careful workers acquainted with the subject, anything I could say would be quite superfluous; to others, anything I could say would also be quite superfluous, although for a different reason.